The effect of ambient evaporative loss on the reproducibility of deuterium oxide dilution measurements assessed by FTIR spectroscopy

IAEA endorses the use of stable isotope techniques to assess body composition in an effort to address public health nutrition impediments around the globe. In particular, the deuterium dilution technique has proven its superiority to anthropometric and bioelectrical impedance analysis by providing high-quality data under diverse experimental settings [1-2]. Total body water (TBW) is often used to assess human body composition in a two compartment approximation model (fat mass, FM, and fat free mass, FFM) under the assumption that the water to lean body mass ratio is constant. Fourier-transform infrared spectroscopy (FTIR) has been successfully used for measuring saliva and plasma with the deuterium dilution technique [1-2] providing high measurement precision and accuracy at low cost. However, for the successful application of FTIR in deuterium oxide dilution measurements, a rigid experimental protocol must be followed. A critical point to consider is whether changes in isotope concentration by evaporative loss or condensation can be eliminated. The aim of this study was to quantify the errors introduced by evaporative loss in diluted deuterium oxide samples of different concentrations, in ambient conditions, using FTIR spectroscopy. A wide O-D absorbance band appear in the mid-infrared region (2650–2350 cm^{-1}) as an unresolved multiple band, centered at approximately 2500 cm^{-1}, involving combinations of symmetric ($_1$) and asymmetric stretching ($_3$) modes. An Agilent 4500 Series FTIR spectrometer was used to measure the absorbance at the peak position (˜2500 cm^{-1}) of aqueous samples of deuterium, in different concentrations, with or without evaporative loss. Our results provide an estimate of the bias due to evaporation and subsequent isotope fractionation under normal and elevated ambient temperatures. Extrapolation of results to wider temperatures range, could suggest correction factors for the assessment of body composition using stable isotope techniques in varied lab and field settings.

Acknowledgments. We gratefully acknowledge support from IAEA under the Regional Project RER/6/034 "Applying nuclear techniques to design and evaluate interventions to prevent and control obesity in adolescents in South-Eastern Europe".

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Session Classification: Poster Session 3

Track Classification: Assessment